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Supporting Materials

Chitosan with Defined Intrinsic Viscosity Enables Physicochemical Entrapment of Microplastics under *In Vitro* Gastric Conditions

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Table S1. Decision matrix: chitosan networks for MP capture[*]

MP Size	Environment	pH ionic / strength	Shear conditions	Optimal chitosan viscosity	Observations
100 - 500 µm (mixed fragments)	Dynamic flow (intestinal lumen, stirred water)	Moderately acidic (pH 4-6), low-medium ionic strength	Moderate shear	90 - 120 cP	Finer mesh increases interception; starch/lipid domains enhance adhesion
	Dynamic flow or semi-static	Acidic to neutral (pH 5-7), medium ionic strength	Moderate - high shear	90 - 120 cP with starch reinforcement	Balanced capture: co-formulation prevents flocculation
> 500 µm (macro-fragments)	Static filtration (membrane, gels)	Neutral (pH 6-7), medium-high ionic strength	Low shear	250 - 450 cP with lipid domains	Robust network resists deformation; suitable for fibrous/membrane structures
Mixed particle	Pulsatile or turbulent flow	Acidic (pH 4-6), variable ionic strength	High shear	90 - 120 cP with lipid domains	Hydrophobic adhesion, fine mesh maximizes capture efficiency
Highly oxidized/charged plastics	Aqueous, suspension	Acidic (pH 4-5), low ionic strength	Moderate shear	90 - 120 cP, DDA ≥ 85-90%	Protonated chitosan maximizes electrostatic binding

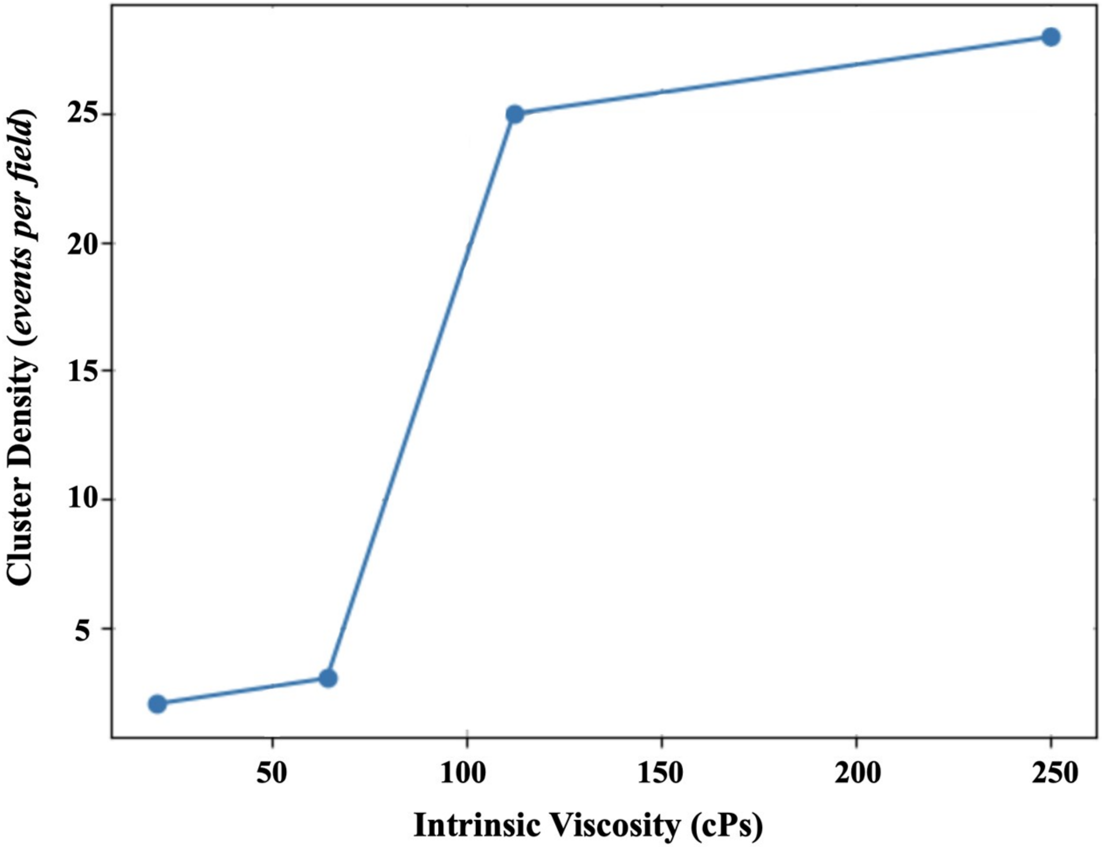
[*] *Viscosity values are determined by the molecular weight and concentration of the chitosan polymer, where higher viscosity (250–450 cP) provides the structural integrity needed for static filtration, while lower viscosity (90–120 cP) allows for the creation of finer, more adaptive meshes in dynamic or high-shear conditions.*

- 90–120 cP chitosan: Ideal for mixed particle sizes, dynamic settings, and tiny mesh. easier to co-gel with lipids and starches.
- 250–450 cP chitosan: Optimal for robust, stationary structures aimed at larger fragments. Provides mechanical strength, although it is less effective for small particles.
- Composite design: Lipids produce hydrophobic domains that "wet" polymers, improving adhesion; starches control porosity and viscosity.
- pH control: Strong electrostatic attraction to oxidized or negatively charged microplastics is ensured by protonated chitosan (acidic conditions).

Functional Contributions of Co-Formulants and pH Sensitivity:

- Lipids (“Wet” Effect): Create hydrophobic domains that “wet” MP surfaces, improving adhesion.
- Starches (Porosity Control): Scaffold the network, maintain viscosity, and regulate mesh size for stable entrapment.
- pH Sensitivity: At acidic pH (1.5–3.5), chitosan amines protonate ($-NH_3^+$), enhancing electrostatic attraction to negatively charged or oxidized MPs

Figure S1. Spatial distribution of polymer networks (*derived from Table 3*)



SEM scoring provided a semi-quantitative representation of the spatial distribution of polymer networks (Table 3). In order to represent structural trends, the categorical interaction scores were transformed into approximate cluster density values (events per field). A threshold-like shift from dispersed polymer–particle interactions to a more linked network structure is confirmed by the resulting plot, which exhibits a sharp increase in cluster density above ~ 90 cPs.